



Course guide

295552 - 295EQ013 - Chemical and Catalytic Reaction Engineering

Last modified: 02/10/2025

Unit in charge: Barcelona East School of Engineering

Teaching unit: 713 - EQ - Department of Chemical Engineering.

Degree: MASTER'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2019). (Compulsory subject).

ERASMUS MUNDUS MASTER IN HYDROGEN SYSTEMS AND ENABLING TECHNOLOGIES (HYSET) (Syllabus 2024). (Optional subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: LLUIS SOLER TURU

Others: Primer quadrimestre:

IGNASI BURGUES CEBALLOS - Grup: T1

AURELIO CALVET TARRAGONA - Grup: T1

KASPER MOTH-POULSEN - Grup: T1

LLUIS SOLER TURU - Grup: T1

PRIOR SKILLS

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

CEMUEQ-01. To apply knowledge of mathematics, physics, chemistry, biology and other natural sciences, obtained through study, experience and practice, with critical reasoning, to establish economically viable solutions to technical problems

CEMUEQ-02. To design products, processes, systems and services of the chemical industry, as well as the optimization of others already developed, taking as a technological base the various areas of chemical engineering, including processes and transport phenomena, separation operations and engineering of chemical, nuclear, electrochemical and biochemical reactions

CEMUEQ-05. To manage and supervise all types of facilities, processes, systems and services of the different industrial areas related to chemical engineering

General:

CGMUEQ-01. Ability to apply the scientific method and the principles of engineering and economics, to formulate and solve complex problems in processes, equipment, facilities and services, in which the matter undergoes changes in its composition, state or energy content, characteristic of the chemical industry and other related sectors among which are the pharmaceutical, biotechnological, materials, energy, food or environmental

Transversal:

06 URI. EFFECTIVE USE OF INFORMATION RESOURCES. Managing the acquisition, structure, analysis and display of information from the own field of specialization. Taking a critical stance with regard to the results obtained.

03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.



LEARNING RESULTS

Knowledges:

K01. Conceive, analyse, design, size, optimise and exploit hydrogen technologies and processes, with a focus on both technology and systems.

Skills:

S01. Communicate effectively with others orally, in writing and graphically about learning, thought processes and decision making, and participate in discussions, using interpersonal skills such as active listening and empathy that support teamwork.

S03. Contribute to innovation in new and existing institutions and business organisations through participation in creative projects, and apply skills and knowledge in entrepreneurship, organisation and technology-based business development.

Competences:

C05. Propose advanced scientific and technological solutions to complex industrial challenges in the field of energy, with a focus on the use of hydrogen as a vector.

C03. Manage the acquisition, structuring, analysis and visualisation of data and information in the field of energy transition and critically evaluate the results of this process.

C02. Work as part of a multidisciplinary team, whether as a team member or in a leadership role, to contribute to the development of projects with pragmatism and a sense of responsibility, undertaking commitments with due regard to the resources available.

TEACHING METHODOLOGY

Classroom. Self-study. Learning from projects and study cases

LEARNING OBJECTIVES OF THE SUBJECT

To develop the technical criteria to define a system of reactors of an industrial process based on chemical, biological, catalysis, mass and heat transfer data, material and energy flows

To obtain the training to analyze scientifically and technologically any kind of chemical or biological reactor and express the bases for its optimization and/or modification

Identify the problems and shortcomings of reactor-based chemical facilities and be able to provide engineering solutions

To reach scientific spirit to investigate new developments in the field of reactors

STUDY LOAD

Type	Hours	Percentage
Hours large group	40,5	27.00
Hours small group	13,5	9.00
Self study	96,0	64.00

Total learning time: 150 h



CONTENTS

Catalysis

Description:

The catalytic phenomenon. Types of catalysis: homogeneous and heterogeneous. Active centers. Langmuir theory. Industrial catalysts. Catalyst evaluation: activity, selectivity, stability and cost. Preparation of catalysts. Design strategies. Common methods of catalyst synthesis. Additives and promoters. Characterization techniques: physical properties of the support, determination and optimization of active centers. Aspects related to mass and heat transfer. Effectiveness and Thiele module. Design strategies

Specific objectives:

To obtain the scientific basis of catalysis and the catalytic systems used at industrial level. Acquire the ability to evaluate the efficiency of catalysts and be able to design and use them successfully in industrial processes

Related activities:

Design of heterogeneous catalysts

Full-or-part-time: 38h

Theory classes: 16h

Self study : 22h

Multiphase reactors

Description:

Fixed bed catalytic reactors. Fluidized and transported catalyst reactors. Reactors G / L. Multiphase reactors G/L/S (slurry, trickle bed). Multifunction reactors and process integration (catalytic distillation, membranes). Reactors with phase change. Agitation and aeration. Reactors with supercritical fluids. Reactor safety

Specific objectives:

To acquire the theoretical and practical concepts of reactors that work in different phases, extrapolating the bases of mass transfer to these units. To acquire the theoretical and practical concepts of the reactors that work with solid catalysts and be able to perform a design and dimensioning of these equipment

Related activities:

Reactor analysis

Full-or-part-time: 38h

Theory classes: 16h

Self study : 22h

Flow Chemistry

Description:

Flow Chemistry Basic Concepts, Flow Chemistry Technology Concepts, Accelerated Discovery, Mixing and Extraction in flow, Principles of Green Chemistry, solvent selection, photo chemistry in flow.

Specific objectives:

Acquire the theoretical and numerical concepts of flow chemistry and their applications.

Related activities:

Analysis of productive systems of flow chemistry and automated experimentation.

Full-or-part-time: 38h

Theory classes: 16h

Self study : 22h



GRADING SYSTEM

Continuous assessment (3 exams, 25% each exam) and completion and presentation of a project (25%). Without reassessment.

EXAMINATION RULES.

Written exams are individual. The project is carried out in groups of two people

BIBLIOGRAPHY

Basic:

- Hagen, Jens. Industrial catalysis : a practical approach [on line]. 2nd ed. Weinheim: Wiley-VCH, cop. 2006 [Consultation: 13/05/2020]. Available on: <https://onlinelibrary.wiley.com/doi/10.1002/3527607684>. ISBN 9783527607686.
- Campbell, Ian M. Catalysis at surfaces. London [etc.]: Chapman and Hall, 1988. ISBN 0412289709.
- Froment, Gilbert F.; De Wilde, Juray; Bischoff, Kenneth B.. Chemical reactor analysis and design. 3rd ed. Hoboken, N.J: John Wiley & Sons, cop. 2011. ISBN 9780470565414.
- Ramachandran, P. A.; Chaudhari L. Catalytic multiphase reactors. Gordon and Breach Sci. Pub., 1984.
- Darvas, Ferenc; Dormán, György; Hessel Volker; Ley, Steven V.. Flow Chemistry. 2nd edition. Berlin, [Germany]: Walter de Gruyter GmbH, 2021. ISBN 9783110693591 / 9783110693614.
- Darvas, Ferenc; Dormán, György; Hessel Volker; Ley, Steven V.. Flow Chemistry. 2nd edition. Berlin, [Germany]: Walter de Gruyter GmbH, 2021. ISBN 9783110693591 / 9783110693614.

Complementary:

- Levenspiel, Octave. Ingeniería de las reacciones químicas [on line]. 3a ed. México: Limusa Wiley, 2004 [Consultation: 23/11/2021]. Available on: <http://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=5758266>. ISBN 9681858603.
- Santamaría, Jesús [etc.]. Ingeniería de reactores. Madrid: Síntesis, DL 1999. ISBN 847738665X.

RESOURCES

Other resources:

Notes from class and other documents from the Digital Campus